REMARKS

In the last Office Action, the Examiner rejected claims 1-5, 17-18 and 21 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,384,232 to Debely. Claims 6, 8, 19 and 38 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,379,244 to Dinger. Claims 10 and 20 were rejected under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,592,663 to EerNisse et al. ("EerNisse"). Claims 11-13, 15-16 and 24 were rejected under 35 U.S.C. §103(a) as being unpatentable over Debely in view of U.S. Patent No. 5,824,900 to Konno et al. ("Konno"). Claims 22 and 25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Dinger in view of Konno. Claims 23 and 26 were rejected under 35 U.S.C. §103(a) as being unpatentable over EerNisse in view of Konno. Claims 28-37 were rejected under 35 U.S.C. §103(a) as being unpatentable over Debely in view of WO0044092 to Fumitaka. Claims 7 and 14 were objected to as being dependent upon a rejected base claim, but indicated to be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claim 27 was allowed by the Examiner.

Applicant and applicant's counsel note with appreciation the indication of allowable subject matter concerning claims 7, 14 and 27. However, for the reasons noted below, applicant respectfully submits that amended

claims 1, 10 and 27 and newly added claims 39-60 also patentably distinguish from the prior art of record.

In accordance with the present response, the specification has been suitably revised to correct informalities and bring it into better conformance with U.S. practice. Original independent claim 1 has been amended to further patentably distinguish from the prior art of record. Original independent claims 1, 10 and 27 have also been amended in formal respects to improve the wording thereof and bring them into better conformance with U.S. practice. Claims 2-9, 11-26 and 28-38 have been canceled. New claims 39-60 have been added to provide a fuller scope of coverage. A new abstract which more clearly reflects the invention to which the amended and new claims are directed has been substituted for the original abstract.

In view of the foregoing cancellation of claims 2-9, 11-26 and 28-38, the following prior art rejections have been rendered moot: the rejection of claims 2-5, 17-18 and 21 under 35 U.S.C. §102(b) as being anticipated by Debely; the rejection of claims 6, 8, 19 and 38 under 35 U.S.C. §102(b) as being anticipated by Dinger; the rejection of claim 20 under 35 U.S.C. §102(b) as being anticipated by EerNisse; the rejection of claims 11-13, 15-16 and 24 under 35 U.S.C. §103(a) as being unpatentable over Debey in view of Konno; the rejection of claims 22 and 25 under 35 U.S.C. §103(a) as being unpatentable over Dinger in view of Konno; the rejection of

claims 23 and 26 under 35 U.S.C. §103(a) as being unpatentable over EerNisse in view of Konno; and the rejection of claims 28-37 under 35 U.S.C. §103(a) as being unpatentable over Debely in view of WO0044092 to Fumitaka have been rendered moot.

Applicant respectfully requests reconsideration of his application in light of the following discussion.

Brief Summary of the Invention

The present invention is directed to quartz crystal tuning fork resonator for undergoing vibration in a flexural mode.

Quartz crystal tuning fork resonators which vibrate in a flexural mode are widely used as a time standard in communication equipment such as wristwatches, cellular phones, and pagers. Due to miniaturization and light weight requirements for these products, such quartz crystal tuning fork resonators must be small with a low series resistance and a high quality factor. However, it has not been possible to miniaturize the conventional quartz crystal tuning fork resonators while achieving a small series resistance and a high quality factor. This is due to the fact that the conventional quartz crystal tuning fork resonators has a small electro-mechanical transformation efficiency which generates a small electric field.

The present invention overcomes the drawbacks of the conventional art. Figs. 1-3 show an embodiment of a quartz crystal tuning fork resonator 1 according to the present invention embodied in the claims capable of vibrating in a flexural mode. The quartz crystal tuning fork resonator 1 has quartz crystal tuning fork tines 2, 3 for undergoing vibration in an inverse phase. Each of the quartz crystal tuning fork tines 2, 3 has a first main surface and a second main surface opposite the first main surface, each of the first and second main surfaces having a central linear portion. The quartz crystal tuning fork tines 2, 3 extend from a quartz crystal tuning fork base 4. At least one groove (5, 6, 11, 12) is formed in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines 2, 3. A width $\underline{W}_2$ of the groove in the central linear portion of one of the first and second main surfaces of each of the quartz crystal tuning fork tines 2, 3 is greater than or equal to a distance $\underline{W}_1$ or $\underline{W}_3$ in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine.

In another embodiment shown in Figs. 15-17, a quartz crystal tuning fork resonator 300 capable of vibrating in a flexural mode has a quartz crystal tuning fork base 303 and quartz crystal tuning fork tines 301, 302 extending from the quartz crystal tuning fork base 303. Each of the quartz crystal tuning fork tines 301, 302 has stepped portions 304,

307 and 305, 314, respectively. At least one first electrode (308, 315) is disposed on each of two of the stepped portions of each of the quartz crystal tuning fork tines 301, 302. At least one second electrode (312, 319) is disposed on a side of each of the quartz crystal tuning fork tines 301, 302. The second electrode of each of the quartz crystal tuning fork tines 301, 302 has an electrical polarity opposite to an electrical polarity of the first electrode of each of the quartz crystal tuning fork tines 301, 302.

By the foregoing construction, the electro-mechanical transformation efficiency of the quartz crystal tuning fork resonators according to the present invention becomes large, thereby enabling the quartz crystal tuning fork resonator to be miniaturized while achieving a low series resistance and a high quality factor.

Traversal of Prior Art Rejections

Claim 1 was rejected under 35 U.S.C. §102(b) as being anticipated by Debely. Applicant respectfully traverses this rejection and submits that amended independent claim 1 recites subject matter which is not identically disclosed or described in Debely.

Amended independent claim 1 is directed to a quartz crystal tuning fork resonator capable of vibrating in a flexural mode and requires a plurality of quartz crystal tuning fork tines for undergoing vibration in an inverse

phase, each of the quartz crystal tuning fork tines having a first main surface and a second main surface opposite the first main surface, each of the first and second main surfaces having a central linear portion. Amended claim 1 further requires a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached, and at least one groove formed in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines. Amended claim 1 further requires that a width of the groove in the central linear portion of one of the first and second main surfaces of each of the quartz crystal tuning fork tines is greater than or equal to a distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine. No corresponding structural combination is disclosed or described by Debely.

Debely discloses a grooved-electrode piezoelectric resonator including two tines 33, 34, grooves 35-38 cut in main surfaces of the tines, and electrodes 39-42 disposed in the grooves. However, Debely does not disclose or describe that structural combination of <u>at least one groove formed in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines</u> and that a width of the groove in the central linear portion of one of the first and second main surfaces of each of the quartz crystal tuning fork tines is <u>greater than or equal to</u> a

distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine, as required by amended independent claim 1.

According to the present invention, by providing at least one groove in the central linear portion of each of the first and second main surfaces of each of the quartz crystal tuning fork tines, the quartz crystal tuning fork resonator has a small series resistance and a high quality factor even when it is miniaturized since the moment of inertia of the quartz crystal tuning fork tines becomes large. Furthermore, the moment of inertia of the quartz crystal tuning fork tines is further increased due to the foregoing relationship between the width of the groove and the distance in the width direction of the groove measured from an outer edge of the groove to an outer edge of the tuning fork tine recited in amended claim 1. No corresponding features are disclosed or described by Debely.

In the absence of the foregoing disclosure recited in amended independent claim 1, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention

anticipation under § 102 can not be found".); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Debely for the reasons stated above. Furthermore, Debely does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Debely's piezoelectric resonator to arrive at the claimed invention.

In view of the foregoing, applicant respectfully requests that the rejection of claim 1 under 35 U.S.C. §102(b) as being anticipated by Debely be withdrawn.

Claim 10 was rejected under 35 U.S.C. §102(b) as being anticipated by EarNisse. Applicant respectfully traverses this rejection and submits that amended independent claim 10 recites subject matter which is not identically disclosed or described in EarNisse.

Amended independent claim 10 is directed to a quartz crystal tuning fork resonator capable of vibrating in a flexural mode and requires a plurality of quartz crystal tuning fork tines each having a plurality of stepped portions,

a quartz crystal tuning fork base to which the quartz crystal tuning fork tines are attached, at least one first electrode disposed on each of two of the stepped portions of each of the quartz crystal tuning fork tines, and at least one second electrode disposed on a side of each of the quartz crystal tuning fork tines, the second electrode of each of the quartz crystal tuning fork tines having an electrical polarity opposite to an electrical polarity of the first electrode of each of the quartz crystal tuning fork tines. No corresponding structural combination is disclosed or described by EerNisse.

EerNisse discloses a resonator temperature transducer having a tuning fork arrangement. However, EerNisse does not disclose or suggest the structural combination of the quartz crystal tuning fork resonator recited in claim 10, including the specific structural limitation of at least one first electrode disposed on each of two stepped portions of each of the quartz crystal tuning fork tines. Since EerNisse does not disclose or describe the structural combination of the quartz crystal tuning fork resonator recited in independent claim 10, there can be no anticipation by EerNisse of independent claim 10 under 35 U.S.C. §102(b). That is, since each and every limitation of independent claim 10 is not found in EerNisse, the reference does not anticipate the claimed invention. See In re Lange, 209 USPQ 288, 293 (CCPA 1981). Furthermore, EerNisse does not

suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify EerNisse's resonator temperature transducer to arrive at the claimed invention.

In view of the foregoing, applicant respectfully requests that the rejection of claim 10 under 35 U.S.C. §102(b) as being anticipated by EerNisse be withdrawn.

Applicant respectfully submits that new claims 39-60 also patentably distinguish from the prior art of record.

New claims 39-46 and 47-49 depend on and contain all of the limitations of amended independent claims 1 and 10, respectively, and, therefore, distinguish from the references at least in the same manner as claims 1 and 10.

New claims 50-52 depend on and contain all of the limitations of allowable independent claim 27 and, therefore, are also allowable.

For the reasons noted above, applicant respectfully submits that newly added claims 54-60 also patentably distinguish from the prior art of record.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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